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"Now you see me, now you don't": The assessment of impulsivity

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Abstract: In the neuropsychological literature, there is a debate concerning whether neuropsychological tests necessarily are better means for assessing impulsivity than are trait measures. Yet, there is an inherent problem in looking at these test results: Cognitive impulsivity (i.e. impulsive performance on a standard task, assessed looking at the speed-accuracy trade-off in the data) might only sometimes be indicative of trait impulsivity, and trait impulsivity might also only sometimes be indicative of cognitive impulsivity. There is, however, no complete overlap. This is the conclusion drawn from two studies reported in this paper. One option is to first look at those participants scoring high on trait impulsivity, and then to interpret their performance on neuropsychological tests in terms of this. Poor performance for them is most likely indicative of impulsive performance. There is, however, another option: That individuals scoring high on trait impulsivity implement this impulsivity in their performance, sometimes performing impulsively, and sometimes not. A plausible solution is to incorporate both self-report and analysis of performance in both neuropsychological assessment and personality research.

Subjects: Behavioral Neuroscience; Mental Health; Psychological Science

Keywords: trait impulsivity; cognitive impulsivity; assessment

ABOUT THE AUTHORS

Yamit Hadad and Tal Ben-Yaacov both completed their dissertations under the supervision of Joseph Glicksohn. Yamit's ongoing interest is in the study of functional and dysfunctional impulsivity. Tal's ongoing interest is in the study of psychopathy. Our research combines cognitive, personality and neuropsychological approaches to the study of impulsivity, sensation seeking, psychopathy, and risk-taking behavior. In the present paper, we take a close look at the relationship between trait impulsivity (i.e. self-reported, using a personality scale, indicating characteristic "lack of planning"), and cognitive impulsivity (i.e. impulsive performance on a standard task, assessed looking either at the speed-accuracy trade-off in the data, or in the type and number of errors in performance).

PUBLIC INTEREST STATEMENT

"Now you see me, now you don't"—why is impulsivity such an elusive phenomenon? Individuals scoring high on trait impulsivity (i.e. self-reported, using a personality scale, indicating characteristic "lack of planning") might implement this impulsivity in their behavior, sometimes acting impulsively, but sometimes not. Would you want an impulsive person on your team? How would you know that this person is impulsive? We address the relationship between trait impulsivity and cognitive impulsivity (i.e. impulsive performance on a standard task, assessed looking either at the speed-accuracy trade-off in the data, or in the type and number of errors in performance). We conclude that cognitive impulsivity might only sometimes be indicative of trait impulsivity, and trait impulsivity might also only sometimes be indicative of cognitive impulsivity. There is, however, no complete overlap. Our suggestion is to first screen for trait impulsivity, and then to interpret performance in terms of this.

1. Introduction

Studies addressing the relationship between impulsivity and criminality, especially juvenile delinquency, have suggested that the effects of impulsivity are stronger in poorer neighborhoods (Jennings & Hahn Fox, 2015; Lynam et al., 2000) and, conversely, are attenuated in more advantaged schools (Eklund & Fritzell, 2014). Indeed, Lynam and Miller (2004, p. 319) have most forcefully argued that this is a well-acknowledged relationship. Nevertheless, they continue to note that differences in the definition of impulsivity might impede progress in this area. While agreeing with this conclusion, one notes a more general problem of definition, in that impulsivity, intelligence, and executive functions all conform to the jingle and jangle fallacies described by Block (1995). The jingle fallacy refers to the misapprehension that various measures implicate the same construct, when they might well be assessing different constructs. One might be referring to a measure assessing trait impulsivity (i.e. self-reported, using a personality scale, indicating characteristic "lack of planning"), or to one testing for cognitive impulsivity (i.e. impulsive performance on a standard task, assessed looking at the speed-accuracy trade-off in the data). Yet, is this the same underlying construct of impulsivity, or rather, as Enticott and Ogloff (2006) propose, several distinct constructs? The jingle fallacy may very well involve all three constructs, as may be seen, for example, in the work of Unsworth et al. (2009). The jangle fallacy refers to the misapprehension that ostensibly dissimilar measures or constructs are different, when actually they are quite similar. Indeed, measures of impulsivity and executive functions might very well be assessing the same type of cognitive functioning, as revealed for example in two recent reviews (Bickel, Jarmolowicz, Mueller, Gatchalian, & McClure, 2012; Cross, Copping, & Campbell, 2011).

These jingle and jangle fallacies are rampant in neuropsychology. For example, Perales, Verdejo-García, Moya, Lozano, and Pérez-García (2009) investigated the relationship between neuropsychological and self-report measures of impulsivity. They compared a female student sample scoring either very high or very low on a measure of trait impulsivity, and contrasted them on a series of tasks testing for neuropsychological (or, cognitive) impulsivity, including reflection-impulsivity, self-regulation, and decision-making. Perales et al. (2009) conclude that trait impulsivity is implicated in response monitoring and inhibition, but not in self-regulation and decision-making. This is an important finding for the literature. Nevertheless, questions do remain regarding this study and its implications.

First, consider the fact that the measure of trait impulsivity employed by Perales et al. (2009), the UPPS-P includes items assessing sensation seeking (Whiteside & Lynam, 2001). While some authors suggest that impulsivity is a higher order construct that incorporates sensation seeking as one of its factors (e.g. Cyders & Coskunpinar, 2011; Whiteside & Lynam, 2001), others suggest that impulsivity and sensation seeking should be considered in separate (Duckworth & Kern, 2011; Glicksohn & Zuckerman, 2013; Zuckerman & Glicksohn, 2016). Second, one task Perales et al. (2009) employed to assess cognitive impulsivity, the Matching Familiar Figures Test (MFFT, testing for reflection-impulsivity), in the end did not discriminate between their high- and low-trait-impulsivity women. Yet the authors argue that this is in line with the notion that cognitive impulsivity is essentially not related to the "core of impulsivity," namely trait impulsivity.

Two contrasting opinions in the literature may be discerned with respect to the utility of trait and neuropsychological measures for assessing impulsivity. One is to use trait impulsivity as major diagnostic criterion, and to employ various neuropsychological tests from which objectively determined indices (such as the number and type of error) then serve as dependent measures, and these may, or may not, subsequently differentiate between individuals scoring high or low on trait impulsivity. This position is exemplified by Perales et al. (2009). The second opinion is exemplified by Gomide Vasconcelos, Sergeant, Corrêa, Mattos, and Malloy-Diniz (2014), who suggest that neuropsychological tests have the advantage both of standardized administration and of overcoming biased self-presentation. Based on such reasoning, one should use cognitive impulsivity as major diagnostic criterion. Nevertheless, Gomide Vasconcelos et al. (2014) were also faced with the fact that trait impulsivity and neuropsychological tasks cannot be used "interchangeably in clinical or research contexts." In other words, different criteria for impulsivity (one based on trait scores, the other based on performance scores) do not necessarily identify the same individuals as being impulsive.

Cognitive impulsivity in the present context refers to impulsive performance on standard cognitive tasks, such as the MFFT and the Porteus Mazes, as indexed by errors in performance or in the speed-accuracy trade-off. Elsewhere, cognitive impulsivity has been used to indicate impulsive performance on tasks of judgment and decision-making. These include the inability to delay gratification in discounting tasks (Arce & Santisteban, 2006) and impaired performance on the Iowa Gambling Task, as reported, for example, by Martin et al. (2004) and by Glicksohn, Naor-Ziv, and Leshem (2007).

What is the relationship between trait impulsivity and cognitive impulsivity (Sharma, Markon, & Clark, 2014)? To what degree can one pinpoint exactly the same individuals as being impulsive, in both the trait and the cognitive domains? In Study 1, the same type of female undergraduate, normative sample as that reported by Perales et al. (2009) is employed. These participants were assessed for trait impulsivity, using the Impulsiveness Questionnaire (Eysenck, Pearson, Easting, & Allsopp, 1985). They further completed a computerized version of the MFFT (Leshem & Glicksohn, 2007), which provided data regarding the speed-accuracy trade-off. Based on these data, one could identify individuals who are impulsive (high error rate and fast RT), or reflective (low error rate and long RT), as well as those who are considered to be "fast-accurate" and those who are considered to be "slow-inaccurate" (Glicksohn & Kinberg, 2009). This enables the independent assessment of both trait impulsivity and cognitive impulsivity.

The participants completed a computerized version of Raven's Standard Progressive Matrices (SPM), imposing a time limit of 20 min, which should influence the final score achieved (non-verbal intelligence). A correlate of performance here is their success on a computerized Group Embedded Figures Test (GEFT; Glicksohn & Kinberg, 2009), which they also completed in the session. The rationale for using these two speeded tasks was that in using a more taxing (and stressful) task situation, one might better be able to draw out both cognitive style (Frost & Lindauer, 1980, p. 223), as revealed in the participant's performance on the GEFT, and impulsive performance (Reeve, 2007). The participants also completed the Porteus Maze Test, which has previously been used to assess cognitive impulsivity (Leshem & Glicksohn, 2007), but which in the past was also used to assess intelligence (Milich & Kramer, 1984).

The goal of Study 1 was to investigate whether participants identified as scoring high on trait impulsivity, would also be identified as scoring high on cognitive impulsivity, when using speeded tasks. In Study 2, the same question was addressed, adopting a converse approach, namely to draw out cognitive impulsivity using tasks that try to trick the participant into revealing impulsive performance. These are the Trail Making Task (TMT) and the Circle Tracing (CT) Task, both of which have the additional benefit of being tasks that are easily employed in a neuropsychological setting. In addition, our normative sample was widened to include both female and male participants, both students and adolescents (high school students).

2. Method

2.1. Participants and the assessment of trait impulsivity

Fifty female students,[1] ranging in age between 20 and 26 (M = 2.3, SD = 1.6), participated in Study 1. This sample was chosen in order to enable a direct comparison with data from a previous study (Glicksohn et al., 2006) employing a similar sample of female university students.

In Study 2, a total of 120 individuals participated: 66 university students (41 females and 25 males), ranging in age between 19 and 30 (M = 23, SD = 2.1); and 54 high-school students (29 females and 25 males), ranging in age between 14 and 16 (M = 15, SD = .6). This sample was chosen in order to enable a direct comparison with data from a previous study (Leshem & Glicksohn, 2007), employing similar samples of participants. The university students participated in the study for the most as part of the BA requirements; the high-school students were paid 50 shekels for participating in the study.

The participants completed the Impulsiveness Questionnaire (I_7; Eysenck et al., 1985) in Hebrew, which has been found to have adequate reliability for trait Impulsiveness ($\alpha = .83$; Leshem & Glicksohn, 2007). In both studies, the reliability values were similar: .83 and .85, respectively, for the university students.[2]

The I_7 has a venerable history (Zuckerman & Glicksohn, 2016). Of the five dispositions of impulsivity coupled with self-report measures of impulsivity that were listed by Cyders and Coskunpinar (2011, Table 1), the I_7 is categorized under the major disposition of "lack of planning," while such dispositions as "lack of perseverance" and "sensation seeking" both rely on the trait of sensation seeking for their assessment. Sensation seeking, one can argue, is not to be equated with trait impulsivity (Glicksohn & Zuckerman, 2013; Zuckerman & Glicksohn, 2016). Thus, in agreement with Cyders (2015, p. 204), it is better to think of trait impulsivity *qua* "lack of planning" here, and of sensation seeking as constituting "separate and distinct tendencies." The I_7 enables one to assess in separate both trait impulsivity and sensation seeking (venturesomeness).

2.2. The assessment of cognitive impulsivity

2.2.1. The Porteus Maze Test (Porteus, 1973)
This is a paper-and-pencil task in which participants must trace their way out of a series of mazes, each more difficult than the other, without entering any blind alleys. Cognitive impulsivity was assessed by means of the *Q* score (qualitative score), using the prescribed weights attached to each type of error made (Porteus, 1973), in line with others (Déry, Toupin, Pauzé, Mercier, & Fortin, 1999). A square-root transformation of *Q* induces a more symmetric distribution (Leshem & Glicksohn, 2007), and this is also the case here. While not addressed by Cyders and Coskunpinar (2011), one can categorize the Porteus Maze Test under "lack of planning." The task has been used to assess cognitive impulsivity (Kendall & Wilcox, 1980; Leshem & Glicksohn, 2007; Milich & Kramer, 1984) in the past, and was employed in both studies.

2.2.2. The Matching Familiar Figures Test (Kagan, 1966)
In Study 1, participants completed the MFFT, which measures cognitive impulsivity. Following Cyders and Coskunpinar (2011, p. 971, Table 2), the particular cognitive process implicated is "prepotent response inhibition." In the computerized version (Leshem & Glicksohn, 2007) employed here, the participant is asked to select one of six alternative pictures that match a standard picture, all pictures being presented simultaneously. There are two dependent measures: total number of errors and mean RT of the first response. A square-root transformation of the number of errors and a logarithmic transformation of mean RT induce more symmetric distributions (Leshem & Glicksohn, 2007), and this is also the case here. Glow, Lange, Glow, and Barnett (1981, p. 290) report reliabilities of .93 and .79 for mean RT and number of errors, respectively, for their automated MFFT.

2.2.3. The Trail Making Test (Lezak, 1995)
In Study 2, the participants completed the TMT, which has been used to assess cognitive impulsivity (e.g. White et al., 1994). In Form A of the TMT, the participant must connect numbered circles in ascending order as fast as possible. In Form B, the participant must draw a connecting line alternating from numbered circles to lettered circles in ascending order. The performance measure was the difference in performance time between parts A and B (Leshem & Glicksohn, 2007). Register-Mihalik et al. (2012, p. 300) have recently reported that reliability for the TMT Form B ranges between .65 and .85. In their review, Bickel et al. (2012, p. 376, Table 1) categorize Form A as measuring "attention" and Form B as measuring "behavioral flexibility." While Cyders and Coskunpinar (2011) do not refer to this task in their review, one may categorize the TMT, as before, under the same missing construct from their Table 2 (p. 971), namely "lack of planning."

2.2.4. Circle tracing (Bachorowski & Newman, 1985)
In Study 2, the participants also completed the CT, which has been used in the past to assess cognitive impulsivity (e.g. White et al., 1994). The CT comprises a 19-cm diameter circle, with the term "START" clearly marked at 0°. Following the procedure of Bachorowski and Newman (1985), the participant is first asked to trace the circle as accurately as possible, and then to trace the circle as slowly as possible. The performance measure is the ratio of the performance times, log-transformed (Leshem & Glicksohn, 2007). One may categorize CT, following Cyders and Coskunpinar (2011, Table 2, p. 971), as assessing "prepotent response inhibition."

2.3. Intelligence and field dependence–independence

2.3.1. Raven's Standard Progressive Matrices (Raven, Raven, & Court, 2003)
In Study 1, participants were tested on a computerized version of Raven's SPM, specially devised for the purposes of this study,[3] which comprises 60 matrices, each of which presents 6 or 8 options for completing a pattern. The task is partitioned into 5 sets of matrices having an increasing order of difficulty. A time limit of 20 min was imposed, which seems to be quite reasonable in light of other studies (Deary, Whalley, Lemmon, Crawford, & Starr, 2000, p. 52; Hamel & Schmittmann, 2006). Performance measures are the number of correct answers achieved and mean RT for correct answers.

In Study 2, participants were tested on the standard (printed) form of the SPM (Raven et al., 2003), imposing a time limit of 40 min, which seems to be quite reasonable, in light of a number of previous studies (e.g. Gonzalez, 2004; Helmes, 1987).

2.3.2. Group Embedded Figures Task (Witkin, Oltman, Raskin, & Karp, 1971)
In Study 1, participants were tested on a computerized version (Glicksohn & Kinberg, 2009) of the GEFT. The task requires the participant to locate a simple figure (any of 8, appearing on a sheet of paper), which is embedded within the complex figure appearing on the screen. The participant attempts to locate the simple figure as quickly as possible, within the time allocated. In Study 1, this was 30 s for each trial. On detecting the figure, the participant presses the space key. After each trial, the complex figure is presented briefly a second time, so that the participant can immediately indicate the embedded figure for the experimenter who then types in whether the participant was correct or not on that trial. Performance measures are the number of correct answers on Sections B and C (ranging between 0 and 18) and mean RT for correct answers.

In Study 2, participants were tested on the standard (printed) form of the GEFT, which comprises 7 practice figures and 18 test figures (Witkin et al., 1971). The task requires the participant to locate as quickly as possible a simple target figure (any of 8, appearing on a separate sheet at the end of the booklet) which is embedded within a complex figure. This is done by outlining the target figure within the complex figure. Section A of the GEFT comprises 7 practice figures, and is not scored; sections B and C each comprise 9 disembedding tasks of varying degrees of difficulty. The time allocated for each of Sections B and C is 5 min. The total number of correct answers on Sections B and C served as the performance measure.

2.4. Procedure
The participants signed an informed consent form, and both studies were approved by the ethics committee of Bar-Ilan University. In Study 1, participants were tested individually in one session lasting approximately one and a half hours. The participants completed the tasks in the following order: The I_7, SPM, Porteus Maze Test, MFFT and the GEFT. Such an invariant order of testing has been described as being "standard practice" (Stevenson & Gernsbacher, 2013), and has been justified as serving "to avoid confounding order effects with individual differences" (MacLeod, Jackson, & Palmer, 1986).

In Study 2, participants were tested individually, and completed the tests in one session lasting approximately two hours. Half of the participants (random allocation) completed the tasks in the following order: The I_7, CT, TMT, SPM, Porteus Maze Test and the GEFT. The other half completed the tasks in the reverse order.[4] All participants further completed a time-production task either prior to or following these tasks (Glicksohn & Hadad, 2012).

2.5. Data analysis

All analyses were conducted using StatView, and included an extensive phase of exploratory data analysis to screen for outliers, check for normality, and to assess the adequacy of the data transformations employed. Descriptive and inferential statistics reported here include the mean and standard deviation of all measures, together with all bivariate Pearson correlations. In order to pinpoint individuals scoring high or low on trait impulsivity and/or cognitive impulsivity, lower and upper quartiles of the respective distributions were inspected.

3. Results

3.1. Study 1: General findings

Summary data for the various measures of Study 1 are presented in Table 1. Both mean (*M*) and standard deviation values for trait impulsivity are similar to those reported previously for a comparable sample of female university students (Glicksohn et al., 2006); the measures for the MFFT closely match those reported from a previous study (Leshem & Glicksohn, 2007). Mean RT for the GEFT closely matches that reported previously (Glicksohn & Kinberg, 2009), while the GEFT score ($M = 9.9$ here) is lower than that previously reported ($M = 12.2$) when using a time window of response of 50 s in that study. The *Q* score is also quite similar to that reported previously (Glicksohn et al., 2006). Inspecting the untransformed *Q* score, using a cut-off value of 32 to indicate very poor performance (Milich & Kramer, 1984, p. 64), one notes that 4 participants achieved such a score. Decomposing this total score into its constituents (e.g. Milich & Kramer, 1984), one can also investigate to what degree the participants differ on the error indicating the lifting of the pencil (LP) from the other sources of error, given that in the past this has been a point of contention as to whether this particular error is indeed indicative of impulsivity (Arbuthnot, Gordon, & Jurkovic, 1987, p. 149; Lapierre, Braun, & Hodgins, 1995, p. 141). A one-way analysis of variance (ANOVA) with repeated measures on these components, revealed a dominance of LP ($M = 8.2$), in comparison to all other sources (*M* ranging between .12 and 2.1 for the other sources of error), $F(6, 24) = 24.5$, $MSE = 15.7$, $p < .0001$.

Table 1. Pearson correlations and descriptive statistics (Mean ± SD) for *n* = 50 female participants in Study 1

	1	2	3	4	5	6	7	8	9
1. Imp									
2. Vent	.25								
3. SPM	.02	.29*							
4. SPM RT	−.04	.22	.43**						
5. Sqrt (*Q* score)	.18	−.03	−.16	−.19					
6. Sqrt (errors) MFFT	−.10	−.11	−.20	.02	.22				
7. Log (RT) MFFT	−.04	.26	.13	.39**	−.11	−.54**			
8. GEFT	.04	−.10	.31*	−.08	.02	−.20	−.01		
9. GEFT RT	.15	−.02	.06	.21	−.06	.02	−.06	−.37**	
M	5.7	7.4	48.2	13.2	3.4	2.1	1.3	9.9	13.8
SD	4.2	3.8	5.1	3.9	1.4	.7	.2	3.6	3.1

Notes: Imp and Vent are from the I_7; SPM denotes Standard Progressive Matrices; MFFT denotes Matching Familiar Figures Test; and GEFT denotes Group Embedded Figures Test.

*$p < .05$.

**$p < .01$.

Turning to the intercorrelations, one notes the following: (1) there is a significant negative correlation between performance measures of the MFFT, in line with the literature (Messer, 1976, pp. 1027–1028); (2) there is a significant negative correlation between performance measures of the GEFT (Glicksohn & Kinberg, 2009, p. 152); (3) there is a significant positive correlation between the SPM performance measures; and (4) there is a positive correlation between the GEFT score and the SPM score, as expected (MacLeod et al., 1986; Phillips & Rabbitt, 1995). In addition to these, we report no significant correlations whatsoever between trait impulsivity and the various indices of cognitive impulsivity, and especially not with the *Q* score.

3.2. Study 2: General findings

Summary data for the subsample of female students who participated in Study 2 are presented in Table S1 in Supplementary Material. Both mean and standard deviation values for trait impulsivity are similar to those reported in both Study 1 and in a previous study (Glicksohn et al., 2006), as is the *Q* score. Both mean and standard deviation values for the SPM score closely match the values reported by Gonzalez (2004, p. 455). The GEFT score is higher than that reported for the computerized version of the task in both Study 1 and when using a time window of response of 50 s (Glicksohn & Kinberg, 2009). The measure for CT is very similar to that reported previously (Glicksohn et al., 2006), as is the delta (difference) score for the TMT. Inspection of the ratio of the time taken to complete TMT, Part B to that for Part A, as suggested by Axelrod, Aharon-Peretz, Tomer, and Fisher (2000), and using their cut-off point of ≤2.5 for unimpaired performance, one notes that a total of 7 female students (17%) have impaired performance.

Turning to the intercorrelations, one notes: (1) that the positive correlation of .31 between the GEFT score and the SPM score reported in Study 1 is replicated here (though due to the smaller *n* this is now non-significant); (2) in contrast to Study 1, the *Q* score now correlates negatively with both the SPM score and with the GEFT score; (3) there is a negative correlation between trait impulsivity and performance on the TMT, of a size comparable to that sometimes reported in the literature (Keilp, Sackeim, & Mann, 2005).

Turning to the whole sample, there is an increase both in GEFT score and in SPM score with age ($r = .53$ and .57, respectively, $p < .0001$), as expected (Witkin et al., 1971). There is a decrease in trait impulsivity with age ($r = -.48$, $p < .0001$), and a decrease in cognitive impulsivity (for the transformed *Q* score, $r = -.28$, $p < .005$)—both confirming previous results (Leshem & Glicksohn, 2007). In addition, SPM and trait impulsivity are negatively correlated ($r = -.40$, $p < .0001$), as expected (Lubinski, 2000); and trait impulsivity and cognitive impulsivity are slightly correlated (for the transformed *Q* score, $r = .24$, $p < .01$).

3.3. Profiling trait impulsivity

Using the upper and lower quartiles to screen the participants of Study 1, a full profile is presented for those individuals scoring high and for those scoring low on trait impulsivity in Table 2. One should justify the use of an extreme-group approach here (Preacher, Rucker, MacCallum, & Nicewander, 2005): The purpose is not to contrast the extreme groups, but rather to present individual profiles of those participants belonging to those extreme groups. One can then see, on an individual basis, whether an individual exhibiting trait impulsivity will necessarily exhibit cognitive impulsivity, and vice versa. As will be seen, this is far from being the case. Consider the performance on the two tasks assessing cognitive impulsivity for those two participants scoring the highest on trait impulsivity (#3, scoring 16, and #4, scoring 15, out of a maximal score of 19). Participant #3 received an untransformed *Q* score of 36, which is above the cut-off score of 32 indicating very poor performance. The major component was a score of 33 for LP. As Evenden (1999, pp. 188–189) stresses, "impulsive execution leads to a failure to follow instructions." In contrast, participant #4 scored 22, which is below the cut-off score but still relatively high, the major component here being a score of 10 for wiggly lines (the maximum score for this component in this sample was 13). As Barratt (1993, p. 41) recalls, "on the Porteus mazes, tracings for high-impulsive subjects were 'wiggly' and suggestive of a fine tremor ...." Turning to performance on the MFFT, we unfortunately were not able to record the data of participant #3 on this task due to a computer mishap. Participant #4 made 5 errors and exhibited a short mean RT of 17.6 s, which is below median. Participant #4 would thus be classified as being impulsive based on her MFFT performance.

Inspection of Table 2 will reveal that high trait impulsivity does not necessarily manifest as high cognitive impulsivity. Indeed, participants #31 and #47 make very few errors on both the Porteus Mazes and the MFFT. Furthermore, low trait impulsivity can also manifest in high cognitive impulsivity. Indeed, participant #8 makes a large number of errors on both the Porteus Mazes and the MFFT. It is thus, perhaps, not surprising that a follow-up series of one-way ANOVAs, comparing participants scoring low, medium, or high on trait impulsivity, revealed not even one significant difference between groups (see Table S2 in Supplementary Material).

Turning now to the data of Study 2, lower and upper quartiles of trait impulsivity were computed in separate for each age group. For the younger participants, these values were 8 and 13, respectively; for the older participants, these values were 2 and 8, respectively. To ease the presentation, the value of 2 will be employed as a lower cut-off point, and the value of 13 will be employed as an upper cut-off point for the whole sample. Of the 12 individuals scoring high on trait impulsivity, a total of four also scored high on cognitive impulsivity, assessed using the *Q* score. Of these, participants #108, #128, and #169 received untransformed *Q* scores of 31, 28, and 31, respectively, which are just below the cut-off score of 32. In contrast, 6 participants scored ≤14, which is well below the cut-off score. Turning to performance on the TMT, the ratio of the time taken to complete Part B to that for Part A for participants #107 (3.4), #110 (5.5), and # 128 (2.9) does indicate impulsive performance.

3.4. Using trait impulsivity to predict the GEFT and the SPM scores

Being impulsive might have benefits when performing a cognitive task, such as the SPM, under a tight time constraint, as in Study 1. That is to say, there might well be a positive correlation between intelligence and "functional impulsivity" (Reeve, 2007; Vigil-Coleț & Morales-Vives, 2005, p. 201). Furthermore, cognitive functions that are needed for successful performance on the SPM, such as working memory, are also crucial for performance on the GEFT and its variants (Miyake, Witzki, & Emerson, 2001). Thus, functional impulsivity might be revealed in high scores on both the SPM and the GEFT. How well do the impulsive participants do here? (see Table 2). For participant #3, her GEFT score was 14 and her SPM score was 46. For participant #4, her GEFT was 15 and her SPM score was 52 (the maximal score in the sample being 58). Thus, in Study 1, our most trait-impulsive participants score quite well on the GEFT (but not necessarily so on the SPM).

A second hypothesis considered was that intelligence and impulsivity should be negatively correlated (Lubinski, 2000): Low intelligence coupled with high impulsivity characterizes delinquency (White et al., 1994); high intelligence coupled with low impulsivity characterizes reflectiveness (Messer, 1976) and better academic success (Vigil-Coleț & Morales-Vives, 2005). Hence, the more intelligent one is, the less impulsive one should be (Messer, 1976). While this hypothesized negative correlation is most clearly seen with respect to intelligence and temporal discounting (Shamosh & Gray, 2008), it is nevertheless a general claim that can be examined. The SPM score sometimes correlates negatively with trait impulsivity ($r = -.40$, in Study 2, as reported above, but $r = .02$ in Study 1), and sometimes so with cognitive impulsivity (*Q* score) for female student participants ($r = -.36$ in Study 2, but $r = .18$ in Study 1).

3.5. Profiling cognitive impulsivity

Using performance on the MFFT as the basis for defining cognitive impulsivity in Study 1, two separate median splits of the sample were conducted, one with respect to MFFT errors, the second with respect to MFFT RT (and both on the transformed variables). This resulted in four groups of participants: Those classified as exhibiting cognitive impulsivity ($n = 19$; high error rate, and fast RT), those classified as being reflective ($n = 18$; low error rate, and long RT), those considered as being fast-accurate ($n = 6$; low error rate, and fast RT), and those considered as being slow-inaccurate ($n = 6$; high error rate, and long RT). Note that the reflective participants and the impulsive participants cogent • psychology

Table 2. Individual profiles for participants scoring either high or low on trait impulsivity (Imp), in Study 1

			High Imp (Imp > 9)										Low Imp (Imp < 3)						
	3	**4**	**31**	**34**	**39**	**40**	**41**	**47**	**1**	**8**	**19**	**20**	**21**	**23**	**25**	**30**	**32**	**33**	**45**
Imp	16[b]	15[b]	11[b]	14[b]	13[b]	10[b]	13[b]	10[b]	1[a]	2[a]	0[a]	0[a]	1[a]	0[a]	1[a]	2[a]	2[a]	2[a]	0[a]
Vent	6	7	13[b]	14[b]	12[b]	6	10	12[b]	4[a]	8	12[b]	9	4[a]	13[b]	3[a]	7	0[a]	5	1[a]
SPM	46	52	44[a]	53[b]	47	56[b]	53[b]	52	53[b]	45	51	55[b]	45	51	45	53[b]	49	38[a]	53[b]
SPM RT	14.2	11.1	8.9[a]	15.9	15.5	23.3[b]	12.5	17.2[b]	15.3	16.8[b]	13.6	10.2	13.8	21.6[b]	18.9[b]	8.3[a]	16.1[b]	10.4	10.2
Q score	36[b]	22[b]	2[a]	14	25[b]	2[a]	13	3[a]	9	21[b]	2[a]	8	5[a]	7	8	12	3[a]	16	8
MFFT errors	?	5	2[a]	3	4	9[b]	5	2[a]	2[a]	9[b]	8[b]	2[a]	0[a]	6	13[b]	4	3	9[b]	5
MFFT RT	?	17.6	24.0	28.6[b]	36.5[b]	20.9	10.1[a]	16.2	43.4[b]	15.5	17.5	23.6	40.9[b]	28.1[b]	12.1[a]	17.2	34.6[b]	18.1	10.8[a]
GEFT	14[b]	15[b]	11	5[a]	4[a]	14[b]	6[a]	9	11	9	7	11	11	10	8	9	13	6[a]	16[b]
GEFT RT	15.7	14.2	14.3	11.9	21.0[b]	11.8[a]	18.8[b]	16.4[b]	12.0	13.4	15.8	11.9	15.8	16.3[b]	10.1[a]	14.3	17.5[b]	11.1[a]	12.0

Notes: Imp and Vent are from the I_7; SPM denotes Standard Progressive Matrices; MFFT denotes Matching Familiar Figures Test; GEFT denotes Group Embedded Figures Test.

[a]Low score (lower quartile).

[b]High score (upper quartile).

together comprise 76% of the sample, which is slightly more than the expected “two thirds of most samples” (Messer, 1976, pp. 1027–1028). For a better comparison with the individual profiles for participants scoring either high or low on trait impulsivity, seen in Table 2, one may look at the upper and lower quartiles of MFFT errors, and of MFFT RT. In such a manner, those classified as exhibiting cognitive impulsivity (n = 6; very high error rate, and very fast RT) could be compared with those classified as being reflective (n = 4; very low error rate, and very long RT). Their data are presented in Table S3 in Supplementary Material. As before, high cognitive impulsivity does not necessarily manifest as high trait impulsivity. High reflectivity, in contrast, is somewhat better aligned with low impulsivity; indeed, two of the participants appearing in Table S3 (#1 and #21) already appear in Table 2. Furthermore, the SPM scores for these participants tend to be higher than for those exhibiting cognitive impulsivity, as one would expect (Lozano, Hernández, & Santacreu, 2015).

In Study 2, using performance on the TMT as a basis for defining cognitive impulsivity (utilizing the ratio of the time taken to complete Part B to that required to complete Part A), the upper quartile (ratio ≥ 2.4) of the sample was selected. In this case, however, a stricter criterion of 2.5 was employed, to align with Axelrod et al. (2000). A total of 23 individuals fulfilled this criterion. Then turning to performance on the Porteus Mazes as a basis for refining the definition of cognitive impulsivity, again selecting the upper quartile (Q score ≥ 27) of the sample, resulted in 9 select individuals who fulfilled both criteria. As before, high cognitive impulsivity does not necessarily manifest as high trait impulsivity. Thus, for example, participant #53, fulfilling both criteria, scored quite low on trait impulsivity (1).

4. Discussion

If the emphasis in Study 1 was on the use of speeded tasks to draw out cognitive impulsivity, in Study 2 a converse approach was adopted, namely to draw out cognitive impulsivity using tasks that try to trick the participant into revealing impulsive performance. The fact that trait impulsivity and cognitive impulsivity are dissociated in both studies comes as no big surprise, if one resigns oneself to the notion that impulsivity is a multi-faceted construct (Gomide Vasconcelos et al., 2014; Leshem & Glicksohn, 2007).

Which measure of impulsivity (cognitive, trait) is a better predictor of future outcomes in the real world? There is no simple answer here. For example, while teacher ratings of self-control and hyperactivity in “non-self-controlled problem children” (Kendall & Wilcox, 1980) indicated an improvement over time in classroom behavior following an intervention, no such corresponding change was seen in measures of cognitive impulsivity (performance on the Porteus Maze test and on the MFFT) assessed over time (Kendall & Wilcox, 1980, p. 89). Thus, trait impulsivity might be a better predictor, but this was not the case in that particular study: Self-report data did not indicate a self-perceived change in behavior.

In contrast to the position expressed recently by Gomide Vasconcelos et al. (2014), it would seem that neuropsychological tests are not necessarily a better means for assessing impulsivity. Cognitive impulsivity might sometimes be indicative of trait impulsivity, as seen in Study 2, and trait impulsivity might also sometimes be indicative of cognitive impulsivity, as seen in both studies. Thus, one option is to first look at those participants scoring high on trait impulsivity, and then to interpret their performance on neuropsychological tests in terms of this. Poor performance for them is most likely indicative of impulsive performance. There is, however, another option: That individuals scoring high on trait impulsivity implement this impulsivity in their test performance, sometimes performing impulsively, and sometimes not (Wingrove & Bond, 1997, pp. 334–335). The converse situation, where individuals scoring high on cognitive impulsivity sometimes also present with trait impulsivity, and sometimes do not, might well be a result of a limitation of neuropsychological testing. For example, the speed-accuracy trade-off in performance on a test, based on which cognitive impulsivity is inferred, might well prove to be susceptible to state effects at the time of testing, such as mood, motivation, interest and the influence of time of day, and thus might not necessarily be indicative of a trait. Thus, performance measures might be more susceptible to fluctuations than are self-report measures.

In support of this, note that while the advantages of neuropsychological testing are in the standardized administration (Gomide Vasconcelos et al., 2014), the assessment of maximized performance (Toplak, West, & Stanovich, 2013), and in the option for repeated use over time (Matusiewicz, Reynolds, & Lejuez, 2011), the disadvantages lie in their vulnerability to transient effects associated with the actual testing conditions (Matusiewicz et al., 2011, p. 531), and the influence of mood and arousal on attentional allocation during performance (Weafer, Baggott, & de Wit, 2013). It is therefore not inconsequential that the assessment of ADHD must take into consideration all of these factors (Schneider, Thoering, Cludius, & Moritz, 2015). A plausible solution to this problem is to incorporate both self-report and analysis of performance in neuropsychological assessment (Duckworth & Kern, 2011, p. 266; Gomide Vasconcelos et al., 2014, p. 242). An individual who is both trait impulsive—especially on the I_7 (Gordon & Egan, 2011)—and exhibits cognitive impulsivity is, by definition, impulsive.

Supplementary material
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Notes

1. An anonymous reviewer has questioned the rationale for employing such an exclusively female sample of participants in Study 1. Apart from the comparison to both the Perales et al. (2009) and Glicksohn, Leshem, and Aharoni (2006) studies, cited above, that employed exclusively female samples, it is worthwhile to note the following studies, also adopting exclusively female samples for studying impulsivity: Marsh, Dougherty, Mathias, Moeller, and Hicks (2002) and Naor-Ziv and Glicksohn (2016).
2. The high-school students completed the I_5 junior Impulsiveness Questionnaire in Hebrew, which has been found to have adequate reliability for trait Impulsiveness (α = .79; Leshem & Glicksohn, 2007). In the present sample, reliability for the female high-school students was similar (.76).
3. Our computerized version was prepared with instructions in Hebrew, especially for this study. Other studies have also employed a computerized version of the SPM (Arce-Ferrer & Martinez Guzmán, 2009; Kornbrot & Greaves, 2005; Meo, Roberts, & Marucci, 2007; Williams & McCord, 2006).
4. An anonymous reviewer has questioned the comparison of Study 1 and Study 2, given this difference in order of testing. There is no simple answer here, for just as one may convince the reader that an invariant order of testing is preferable (Study 1), so one may equally convince the reader that order of testing should be varied across participants (Study 2).

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